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Zinc Sorption by Six Agricultural Soils Amended with Municipal Biosolids

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Abstract : Anthropogenic sources of zinc (Zn), including industrial emissions and effluents, Zn–rich fertilizer materials and pesticides containing Zn, can contribute to increasing the concentration of soluble Zn at levels toxic to plants in acid sandy soils. The application of municipal sewage sludge or biosolids (MBS) which contain metal immobilizing agents on coarse-textured soils could improve the metal sorption capacity of the low-CEC soils. The purpose of this experiment was to evaluate the sorption of Zn in surface samples (0-15 cm) of six Quebec (Canada) soils amended with MBS (pH 6.9) from Val d'Or (Quebec, Canada). Soil samples amended with increasing amounts (0 to 20%) of MBS were equilibrated with various amounts of Zn as ZnCl2 in 0.01 M CaCl2 for 48 hours at room temperature. Sorbed Zn was calculated from the difference between the initial and final Zn concentration in solution. Zn sorption data conformed to the linear form of Freundlich equation. The amount of sorbed Zn increased considerably with increasing MBS rate. Analysis of variance revealed a highly significant effect ($p \leq 0.001$) of soil texture and MBS rate on the amount of sorbed Zn. The average values of the Zn-sorption capacity of MBS-amended coarse-textured soils were lower than those of MBS-amended fine textured soils. The two sandy soils (86-99% sand) amended with MBS retained 2- to 5-fold Zn than those without MBS (control). Significant Pearson correlation coefficients between the Zn sorption isotherm parameter, i.e. the Freundlich sorption isotherm (KF), and commonly measured physical and chemical entities were obtained. Among all the soil properties measured, soil pH gave the best significant correlation coefficients ($p \leq 0.001$) for soils receiving 0, 5 and 10% MBS. Furthermore, KF values were positively correlated with soil clay content, exchangeable basic cations (Ca, Mg or K), CEC and clay content to CEC ratio. From these results, it can be concluded that (i) municipal biosolids provide sorption sites that have a strong affinity for Zn, (ii) both soil texture, especially clay content, and soil pH are the main factors controlling anthropogenic Zn sorption in the municipal biosolids-amended soils, and (iii) the effect of municipal biosolids on Zn sorption will be more pronounced for a sandy soil than for a clay soil.

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